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PLAN FOR PLANET-A SATELLITE

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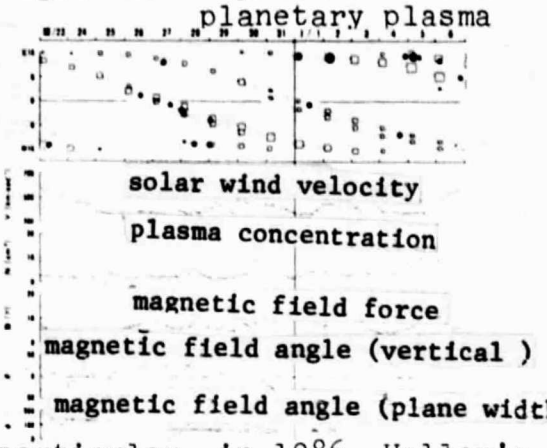
WASHINGTON D.C. 20546 DECEMBER 1980

One example of this is shown in Figure 1. This is an outline of "Temporal and Spatial Transformations" of the solar winds.

Figure 1. Aspects of interplanetary plasma



The solar winds sometimes change momentarily in these aspects. Consequently, as atmospheric phenomena in the atmosphere are observed, it is necessary to observe the aspects of solar winds for the explanation of astrogeophysical phenomena.

Therefore, comets come flying /2 into the raging solar winds. In particular, in 1986, Halley's Comet will approach the Sun during its 75.7 year cycle. It will also be possible for Planet-A to observe Halley's Comet, which will trail through solar wind plasma. Besides analyzing the interaction of Halley's Comet and solar winds, it will also be a splendid opportunity to observe the Comet itself. Professor Alfuben of Sweden explains it in this way when discussing future space plans at NASA: "The Comet is one of the fossils from the time of the formation of the solar system". Planet-A will pass Venus during its flight. This will be a splendid opportunity to observe the composition of the planet's upper atmosphere with the ultraviolet ray analyzer which will be set up. In this way, Planet-A will be a multipurpose probe that can make various observations.

3. Solar wind plasma and comets--The objects of observation

The following observations will be performed on Planet-A:

I) Magnetic field vector (3 components),

II) current speed, concentration, temperature and direction of the plasma particles,

III) spectrum and force of the plasma undulation and

IV) classification of substances making up the comet and its interaction with the solar winds.

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16. Abstract

A description is given of the plan for Planet-A which will be launched by Japan in January 1985. In 1986 this probe will approach Halley's Comet. The tests to be made by this probe are discussed.

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PLAN FOR PLANET-A SATELLITE

/1*

TOKYO UNIVERSITY SPACE RESEARCH LABORATORY
PLANET RESEARCH GROUP OF THE SPACE OBSERVATION COMMITTEE

1. Prologue

Mankind is studying the universe. The era of the Earth satellite which was started by the Soviet Union in 1957 lasted until, finally, the United States put man on the moon in the 1960's. In the 1970's, Voyager developed images of Jupiter and its satellites which had been a mystery for eternity before our very eyes. The era of the solar system will develop with the coming of the 21st Century. We may even have reached this point already.

We have not examined our country's involvement in activities in which the world is aiming for the universe in this way. After going through the era of substratospheric tests by rockets, "Osumi" finally became our first scientific research satellite in 1970. In 1979, the standard satellites of "Kyokkō", "Jikiken" and "Hakuchō" continued to send priceless information concerning astrophysics and the far away universe back to Earth while they soared into space.

Today, even in our country, it is planned that a major space mission be sent into space. A plan for Planet-A has been set up by combining the strengths of both space science and space engineering. The probe will take off from Earth in January, 1985, and fly into the plasma which fills interplanetary space. There it will observe the conditions of plasma of raging solar winds and Venus. Also, if all systems are go, in 1986 the probe will approach Halley's Comet which will be plunging toward the Sun.

Technical problems that we have never experienced will probably occur in long term spacecraft nagivation by radio wave transmission

*Numbers in margin indicate pagination of foreign text

which requires several minutes one way. However, our country's new challenge to interplanetary space will also kindle a bright and strong light in the international community which is eagerly aiming for the stars.

Together, Japan, the United States, the Soviet Union and Europe will probably participate in the observation of interplanetary space.

2. Purpose and Considerations

The third planet of the solar system, Earth, and the other planets, are submerged in solar winds. However, Earth has a sufficient magnetic field and intrusion of solar winds is prevented. Consequently, tne Earth has a sphere of influence and there is unlimited direct contact with the solar winds which stop inside of the magnetic field.

On the other hand, even though there is a large change in the solar winds, they do affect the magnetic field and these effects sometimes accumulate. The electromagnetic field and plasma energy in this magnetic field largely control the electromagnetic phenomena which develop in the substratospheric region of the Earth. It becomes an explosion of a large aurora. Electrical waves which are emitted 1 kilometer into space from Earth are produced. Intrusion of the large scale electrical field controls the action of plasma inside the ionosphere and produces heat. This is the main cause of the radiation belt.

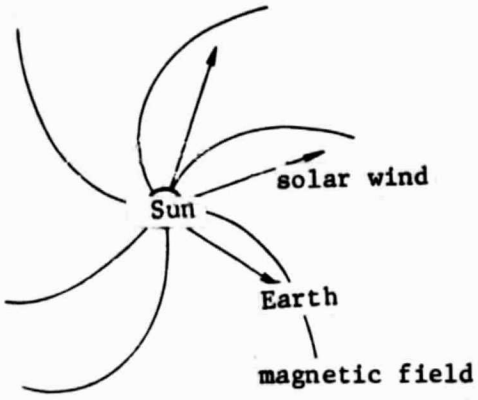
Consequently, because we know the conditions of the solar winds in detail, we know the source of control of the electromagnetic phenomena of the Earth. The Sun behaves violently and solar winds blow violently. While aspects of the winds' currents change, they fill interplanetary space.

Using radio waves for the transmission of data, we will also inspect the fluctuation of solar winds and test the theory of relativity.

3-1. Magnetic field vector analysis.

The magnetic field of the solar system is 1 gauss around the Sun. In relation to the outflow of the plasma current and rotation of the sun, the magnetic field forms an archimedean screw that pulls to the outside. Near the Earth it is 5×10^{-3} gauss (refer to Figure 2).

Figure 2.



Therefore, with observations collected up until now, this information does not exceed average standards. There are large changes in the composition and huge fluctuations in this information which extends over a solar action cycle of 11 years. There will be detailed observation of hydroelectromagnetic waves which are transmitted through the plasma of interplanetary space.

3-2. Plasma Analysis /3

Solar wind plasma travels from the sun into interplanetary space and is emitted at an average speed of 350 km/second (refere to Figure 2). Near the Earth the plasma is made up of an average of 5 protons per cubic centimeter. Even the concentration and current speed of the solar wind plasma can give only an average picture. The excited state of solar wind plasma is characteristic. Plasma analysis is the exact analysis of strong irregularities, such as a) shear speed, b) concentration and gradient, and c) aelotropy in the excited solar wind plasma.

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3-3. Analysis of plasma fluctuations

Strong plasma fluctuations are produced in the unstable solar wind plasma. This results in interaction between the plasma fluctuation and particles. Particle movement is obstructed by plasma fluctuation and collisions occur among the particles. The resulting interplanetary space plasma is a fluid body that is viscous in spots from the viewpoint of time and space. Consequently, in order to discover the composition of plasma in the solar system, we must analyze precisely the temporal fluctuations and spectrum of plasma fluctuations which develop.

3-4. Ultraviolet ray observation of Halley's Comet and Venus

Huge masses that are far away in the vast interplanetary space sometimes fall toward the Sun at a very high speed. They pass by the Sun and then once more go far off into space. There are called comets. Among these comets, Halley's Comet comes from near the orbit of Neptune. This comet has a typical cycle of about 76 years. The comet gases are stirred by solar winds and leave a large trail. A detailed look at the comet's composition is an important key to knowing the original substance that gave birth to the solar system together with knowing precisely the solar wind conditions.

These observations are done mainly with an ultraviolet ray analyzer. This analyzer will also analyze the atmosphere of Venus when Planet-A passes the planet.

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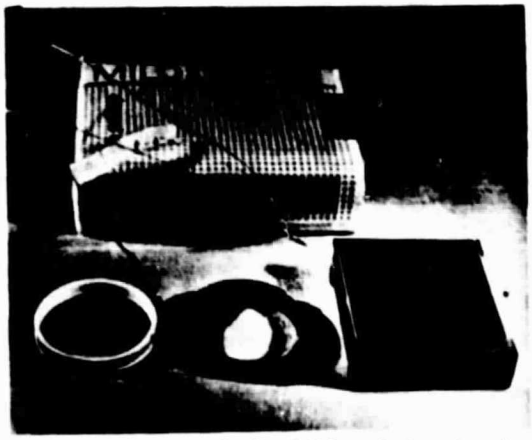
4. Scientific Analyzers

4-1. Magnetic field analyzer

In order to determine the conditions of the solar system in detail, a magnetometer that has enough power to detect minute fields of less than 1/10,000 of the Earth's magnetic field is necessary. Therefore, we are planning to use the fluxgate magnetometer.

Since fluxgate magnetometer is highly sensitive, we will know ahead of time if circumstances are favorable by using the ring style magnetic core. This technique is peculiar to our country and has taken root here. It can also detect stability and weak points from changes in temperature. Its largest range of analysis is 5×10^{-4} gauss. In order to perform a magnetic field analysis with a high degree of accuracy, the power of the remaining magnetic field of the spacecraft itself is reduced and a boom that is more than 2 meters long protrudes from the spacecraft. The tip of the boom is equipped with a ring core type sensor.

Figure 3

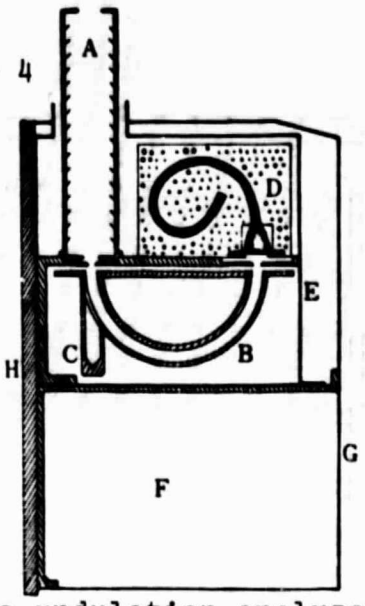


4-2. Plasma Analyzer

The plasma that fills the solar system is from solar winds and we have already explained that the winds change violently. The plasma analyzer is an energy particle analyzer that will have the standards mentioned below. The objects for determination will be present in a concentration of 1-100 objects/cc. Their temperature will be between an electron of several electron volts and a proton of tens of electron volts and they will have a solar wind speed corresponding to 1 kiloelectron volt. It is necessary to plan an analyzer whose capability to analyse energy is very high.

This analyzer combines the hemispherical electrostatic analyzer and the channeltron electronic magnifier. Figure 4 shows its basic design.

Figure 4

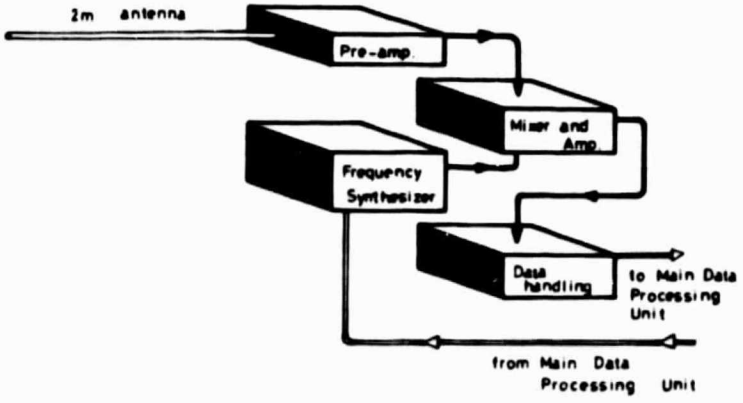


Key:
A) colorimeter
B) hemispherical electrostatic analyzer
C) high energy particle trap
D) channel multiplier
E) magnetic force shield case
F) high pressure electrical source preamp
G) receiving case
H) operating console

4-3. Plasma undulation analyzer /5

Plasma undulation transfers the frequency range (which extends to 5 yards) 0.5 Hz to 50 KHz, to channel 32 and selectively amplifies the range using a 3 meter monopole antenna. This includes the important parameters of plasma frequency and electrocyclotron frequency. The receiver can amplify 0.1 μ volts to 1 volt. This analyzer has an amplification factor that is one million times that of the stabilized selective frequency. This analyzer has been established for long term transmission of spacecraft observations in a magnetic field.

Figure 5



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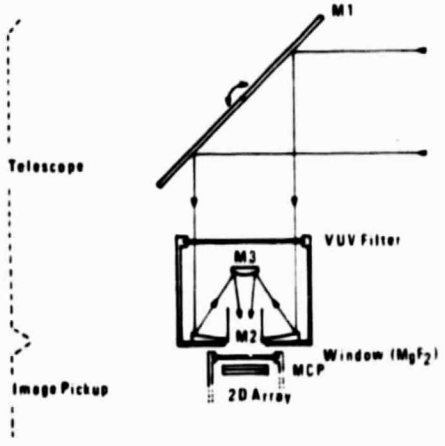
4-4. Analyzer that takes pictures of ultraviolet rays in a vacuum

We will observe the ultraviolet rays of Halley's Comet in a vacuum. The nuclei will form and at the same time we will have equipment to analyze the hydrogen atoms and oxygen atoms that are released. In this plan a wide angle Schmidt camera will be used. A clear image of the distribution of the radiation source will be formed from elements which extend to 2 dimensions and are mixed with atoms that have a high number of electrons. In this way we will be able to take a highly sensitive photograph. In order to capture the comet that flies through space and Venus at a distance of 0.3 AU, we will use a projectile. The angle of the projectile will be controlled. The fact that this optical system is small and light weight is important and its development is progressing with the technique that uses probes which circle the Earth.

Figure 6

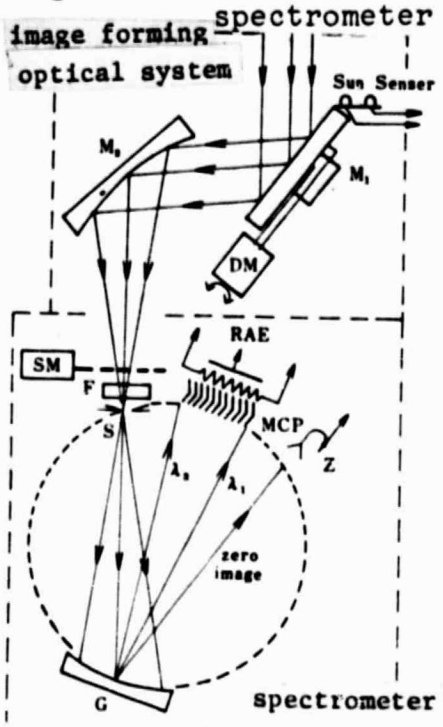


4-5. Analyzer of ultraviolet spectra in a vacuum

Pictures of the radiation source of ultraviolet rays in a vacuum must capture the spatial characteristics and spectra in detail. With the spectrum distribution analyzer, this equipment will determine precisely the amount of hydrogen, hydrocarbons, CO_2^+ ions and OH molecules which exist on Halley's Comet and Venus. Figure 7 is a diagram of the spectrometer. Plane mirror M_1 is turned upward at driving motor DM and is inclined at a 50° angle. The radiation source will be analyzed using a spin. Spectral diffraction will be performed using the concave diffraction grating G.

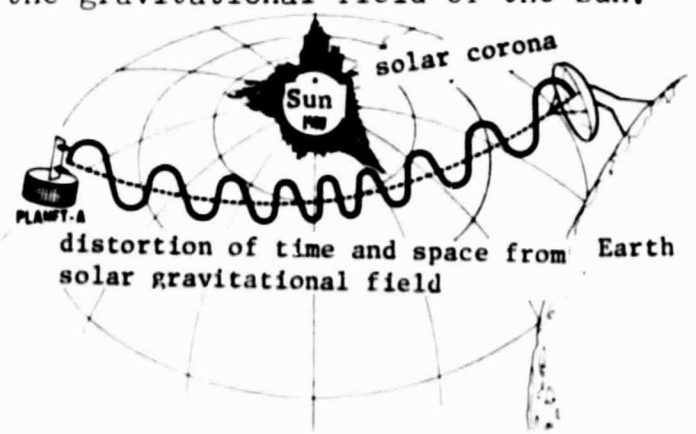
The ultraviolet rays which are diffracted in a vacuum will be collected by the microchannel plate (MCP). Spectral diffraction will be possible at a width of 7 Å. /6

Figure 7. Outline of the spectrometer



4-6 Scientific test of the radio wave application

Planet-A will use microfrequency radio waves centered around S band in transmission. These radio waves will be used in data transmission from the satellite. At the same time, we will be able to discover interplanetary space conditions from characteristics of this transmission using radio waves. In particular, the radio waves will pass very close to the Sun and when they are received on Earth, they will be strongly influenced by the Sun. We will be able to probe plasma conditions of the Sun from the lag in fluctuations and phases from the solar corona plasma, the frequency, rotation of poles, etc., while also testing Einstein's Theory of Relativity by observing the phenomenon in which radio wave transmission speed is delayed and refracted because time and space (four dimensional time and space) are distorted by the gravitational field of the Sun.



This plan is still in the testing stages and has not been formally approved.

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